CLAIMS

1. Power autonomous portable electric tool set, such as, for example, pruning scissors, a saw, a fruit picking tool, lawnmowers, a bush cutter, a hedge cutter, an impact spanner, a pneumatic hammer, comprising at least three distinct functional sub-units, namely, a first sub-unit generating the mechanical operation of the tool by means of an electric actuator, a second sub-unit forming the electric energy source of the set and essentially including a rechargeable electrochemical battery, a third charger sub-unit capable of carrying out the electrical recharging of the electrochemical of the battery of the second sub-unit, characterized in that the first sub-unit (2) is connected to the second sub-unit (3), at least during use of the tool, by a flexible electrical cord (6), on the one hand, and in that the electric supply of the actuator that constitutes it can be cutoff automatically and/or at will by the operator, on the other hand; the second sub-unit (3) is portable and is provided with a lithium-ion or lithium polymer battery formed by association of a series of cells, each cell being comprised of one element or a plurality of associated parallel elements, on the one hand, and with one or a plurality of electric or electronic modules for controlling and/or managing the battery, these modules being located in the vicinity of the battery; the third charger sub-unit (4) comprises at least one electric supply source, the voltage and current of which are adapted to recharging the lithium-ion or lithium polymer battery (5) this third sub-unit being electrically connected to the second sub-unit by a disconnectable flexible cord (10).
2. Electric tool set according to claim 1, characterized in that the flexible cord (6) that connects the first sub-unit (2) to the second sub-unit (3) is provided with a connector (24) toward the second sub-unit (3).
3. Electric tool set according to claim 1, characterized in that the flexible cord (6) that connects the first sub-unit (2) to the second

sub-unit (3) is provided with a connector (25) toward the first sub-unit (2).

4. Electric tool set according to claim 1, characterized in that the flexible cord (6) that connects the first sub-unit (2) to the second sub-unit (3) is provided with a connector (25) toward the first sub-unit (2) and also with a second connector (24) toward the second sub-unit (3).

5. Electric tool set according to claim 1, characterized in that the first sub-unit (2) is equipped with a system for automatically cutting off its electric supply when the battery voltage has reached a minimum low level prior to the deterioration, by significant loss of capacity and increase of spontaneous discharge, of the lithium-ion or lithium polymer battery equipping the second sub-unit (3).

6. Electric tool set according to claim 1, characterized in that one module among the electric or electronic module(s) for controlling and/or managing the battery equipping the second sub-unit (3) has the function of automatically cutting off the electric supply of the first sub-unit (2) when the battery voltage has reached a minimum low level prior to the deterioration, by significant loss of capacity and increase of spontaneous discharge, of the lithium-ion or lithium polymer battery equipping the second sub-unit (3).

7. Electric tool set according to claim 1, characterized in that one module among the electric or electronic module(s) for controlling and/or managing the battery equipping the second sub-unit (3) has the function of automatically cutting off the electric charge of the battery when the voltage delivered by the third charger sub-unit (4), to which it is connected, has reached a maximum value prior to the deterioration, by significant loss of capacity and increase of spontaneous discharge, of the lithium-ion or lithium polymer battery equipping the second sub-unit (30).

8. Electric tool set according to claim 1, characterized in that one module among the electric or electronic module(s) for controlling and/or managing the battery equipping the second sub-unit (3) has the function of automatically cutting off the electric charging of the

battery when the charging current for the battery has reached a minimum low level recommended or required by the manufacturer of the lithium-ion or lithium polymer battery equipping the second sub-unit (3).

9. Electric tool set according to claim 1, characterized in that one module among the electric or electronic module(s) for controlling and/or managing the battery equipping the second sub-unit (3) has the function of protecting the battery against short circuits.

10. Electric tool set according to claims 1 and 9, characterized in that the function of protecting the battery against short circuits is carried out by a fuse arranged at least at one of the terminals of the battery of the second sub-unit (3).

11. Electric tool set according to claims 1 and 9, characterized in that the function of protecting the battery against short circuits is carried out by a circuit breaker or a similar component arranged at least at one of the terminals of the battery of the second sub-unit (3).

12. Electric tool set according to claim 1, characterized in that one module among the electric or electronic module(s) for controlling and/or managing the battery equipping the second sub-unit (3) has the function of placing the battery in no consumption or very low consumption mode during the period of non-use of the first sub-unit (2).

13. Electric tool set according to claims 1 or 12, characterized in that the function of placing the battery 5 in no consumption or very low consumption mode during the period of non-use of the first sub-unit (2) is carried out by a switch arranged at one of the terminals of the battery, and preferably after the fuse or the circuit breaker, if the latter are installed.

14. Electric tool set according to claim 1, characterized in that the third sub-unit (4) is equipped with a system for automatically cutting off the electric charge of the battery of the second sub-unit when the voltage of the battery has reached a maximum high level prior to the degradation of the lithium-ion or lithium polymer battery equipping the second sub-unit (3).

15. Electric tool set according to claim 1, characterized in that the third sub-unit (4) can be equipped with a system for automatically cutting off the electric charging of the second sub-unit when the charging current of the battery has reached a minimum low level recommended or required by the manufacturer of the battery equipping the second sub-unit (3).

16. Electric tool set according to claim 1, characterized in that the elements of the lithium-ion battery of the second sub-unit are in the commercial 18650 size.

17. Electric tool set according to claim 1, characterized in that the second sub-unit (3) can be provided with a single module (26) for controlling and/or managing the battery, which is made in the form of one or several electronic boards and includes at least one digital processing unit (21), such as a microprocessor, a microcontroller, a digital signal processor, for example, associated with a memory and with annexed digital and/or analog circuits.

18. Electric tool set according to claims 1 and 17, characterized in that the module for controlling and/or managing the battery of the second sub-unit (3) is capable of performing one or several of the following tasks:
managing the charging,
managing the discharging,
balancing the charging of each cell (8),
evaluating and displaying the capacity of the battery (5),
protecting the battery (5) during discharging against excess current when the tool is being used,
managing the tool during the storing phases,
managing the alarms,
managing and transmitting the information collected,
managing the diagnostics

19. Electric tool set according to claims 1, 17, and 18, characterized in that in view of completing the tasks of managing the charging, managing the discharging, balancing the charging of each cell (8), evaluating and displaying the capacity of the battery (5), the

controlling and/or managing module constantly exploits the voltage measuring values of each cell (8) composing the battery (5).

20. Electric tool set according to claims 1, 17, 18, and 19, characterized in that for a battery (5) formed of serially associated n-cells (8), the voltage measuring values of each cell (8) are furnished by an acquisition electronic chain (27) constituted mainly by identical analog n-modules (28) mounted at the terminals of the n-cells (8), respectively, of the battery (5) and capable of measuring the voltage of the corresponding cell (8), respectively, the values of the voltages measured by each of the n-modules (28) being then directed, one after the other, by means of at least one analog multiplexer (29) and after amplification by an adapted circuit (30), toward an input analog/digital converter (21') of the digital processing unit (21) of the module for controlling and/or managing the battery of the second sub-unit (3).

21. Electric tool set according to claim 20, characterized in that the analog modules (28) for measuring voltage perform a subtraction for each cell (8), respectively, between the voltage measured at its positive terminal and the voltage measured at its negative terminal, by means of a differential electronic circuit with operational amplifier (28') using resistances (28") or input resistive elements.

22. Electric tool set according to claim 21, characterized in that the differential electronic circuit with operational amplifier (28') of each voltage measuring module (28) comprises resistances or input resistive elements (28") having an impedance close to or greater than 1 Mohm, so as to obtain very low leakage currents, for example, less than $1/20000^{th}$ per hour of the total capacity of the battery (5)

23. Electric tool set according to claims 19-22, characterized in that the measuring values of the voltage of each cell (8) are delivered with a measuring precision of at least 50 mV.

24. Electric tool set according to claim 23, characterized in that the measuring precision of the voltage of at least 50 mV is obtained by

calibration during the manufacture of the electronic board of the module (26) for controlling and managing the battery.

25. Electric tool set according to claim 24, characterized in that calibration during the manufacture of the electronic board involves programmatically inputting error correcting parameters in the digital processing unit (21), for each voltage measuring module (28), as a function of the measurement of one or several very precise reference voltages which, for this calibration operation, are substituted for the voltages that are normally measured at the terminals of each cell (8).

26. Electric tool set according to any of claims 17-25, characterized in that the task of balancing the charging of the cells (8) with respect to one another is managed by the digital processing unit (21) which controls the change in the charging current, based on the voltage measuring values of each cell (8) and, if necessary, for each of them, by means of dissipating circuits using electronic switchers (31) associated with resistive elements (31').

27. Electric tool set according to any of claims 17-25, characterized in that the task of managing the discharging involves constantly checking the voltage data of each cell (8) by means of the digital processing unit (21), interrupting the discharging when the unit detects that one of these voltages of a cell (8) has reached the minimum discharge threshold recommended by the manufacturer of the lithium-ion or lithium polymer elements, and cutting off the discharging by deactivating a discharge switching component (32), thus resulting in the tool (2) being stopped, and by activating, for example, a sound or visual warning signal.

28. Electric tool set according to any of claims 17-27, characterized in that the tasks of managing the charging, evaluating and displaying the capacity of the battery (5) and of protecting against excess current during the discharging are continuously managed by the digital processing unit (21) due to an analog electronic circuit (33) measuring the charging and discharging current of the battery (5)

29. Electric tool set according to claim 28, characterized in that during the task of managing the charging, while the third charger sub-unit (4) is connected to the second sub-unit (3) in the area of the electronic board of the module (26) controlling the battery (5), the end of the charging is obtained by opening a charge switching component (34) that is controlled by the digital processing unit (21) when, by means of the analog electronic circuit (33) measuring the charging and discharging current, said unit 21 detects a drop in the charging current down to a recommended threshold, for example 50 mA, for the battery (5), on the one hand, or when the temperature of the battery (5) exceeds an authorized limiting value, for example 45°C, on the other hand; or yet when the charging continues for a period of time that is greater than a given fraction of the theoretical charge time, for example, about 20%.

30. Electric tool set according to claim 28, since it is dependent upon one of claims 17-25, characterized in that the task of evaluating and displaying the capacity of the battery (5) is managed by the digital processing unit (21), the latter calculating said capacity by constantly taking into account, during the charging and during use of the tool, the information related to the instantaneous charging and discharging current of the battery (5) delivered by the analog electronic circuit (33) for measuring the charging and discharging current, on the one hand, and the voltage measuring values of each cell (8) and, not necessarily but for a more accurate calculation, their known average internal resistance.

31. Electric tool set according to any of claims 17-30, characterized in that the task of protecting against excess current during the discharging of the battery (5) during use of the tool, adapted to preserve the lithium-ion or lithium polymer battery from premature aging or from overheating, involves either cutting off the discharging current in the case of a very substantial pulsed overload of the maximum discharging current allowed for the battery (5), or an excess of the maximum temperature allowed for the latter, or limiting the discharging current as a function of the energy

consumed by the tool during a certain sliding time period, knowing that the value of the energy and the sliding time period are experimentally predetermined as a function of the tool, its use and the cycle life desired for the lithium-ion or lithium polymer battery (5) of the second sub-unit (3).

32. Electric tool set according to claim 31, characterized in that the discharging current limitation is managed by the digital processing unit (21) by applying a pulse width modulation (PWM) control, generated either directly by said unit (21), or by a special component, through a control stage (35), to the discharge switching component (32) made, for example, in the form of an N-channel Mosfet type component.

33. Electric tool set according to any of claims 17-32, characterized in that when it is not being charged and has not been used for a given period of time, for example 10 days, the digital processing unit (21) automatically undertakes a storage managing task, which involves verifying whether or not the residual capacity of the battery (5) is greater than the storage capacity recommended by the manufacturer of the lithium-ion or lithium polymer elements, and, if the residual capacity is indeed greater than the storage capacity, having the digital processing unit (21) initiate an automatic discharging of the battery by means of resistive circuits (31, 31') connected in parallel on each cell (8), until the storage capacity is reached, and, consequently, stopping all of the electronic circuits while placing the processing unit (21) in low consumption stand-by mode, and, if the capacity is below the storage capacity, having the digital processing unit (21) set off a sound and/or visual alarm.

34. Electric tool set according to any of claims 17-33, characterized in that the digital processing unit (21) is capable of detecting the live connection of the charger (4) to the battery (5) by means of a voltage measurement carried out by the control module (26) at least at one of the terminals (37) of the second sub-unit (3) adapted to be connected to said charger (4).

35. Electric tool set according to claim 34, characterized in that the function of detecting the live connection of the charger (4) to the battery (5) is carried out by means of a particular adapted measuring circuit (36), making it possible to initiate an automatic recharging of the battery (5) as long as the tool is stored in a non-use phase, by detecting the instant when at least one cell (8) has reached the minimum voltage recommended by the manufacturer.

36. Electric tool set according to claim 34 or 35, characterized in that when the controlling and/or managing module (26) detects an excessive or insufficient voltage of the charger (4) in the area of the corresponding connection terminals (37) of the second sub-unit (3), the digital processing unit (21) that uses this information orders the interruption of the charging and sets off a sound and/or visual alarm.

37. Electric tool set according to any of claims 17-36, characterized in that the task of managing the information and diagnostics involves storing in the memory of the digital processing unit (21) information that is acquired during use of the tool, such as, for example: the number of recharges, the computation of the number of hours the tool was used, the change in the capacity of the battery (5) in time, the average energy consumed by the tool, or similar information, this information being capable of being transmitted by means of a wire, radiofrequency, or infrared connection (40) toward a separate operating terminal, such as, for example, a personal computer, an electronic personal assistant, GSM, which can possibly be connected to the Internet.

38. Electric tool set according to any of claims 17-37, characterized in that the module for controlling and/or managing the battery of the second sub-unit (3) forming a rechargeable electric energy source is associated to the electronic module for controlling the actuator (2) on the same electronic board, with use of the same digital processing unit (21), if necessary.

39. Electric tool set according to any of claims 17-37, characterized in that the module for controlling and/or managing the battery

comprises, for each cell (8), safety redundant circuits (38) for stopping the charging, each being individually capable of controlling the general interruption of the charging, in the case of a voltage overload of a cell (8), by directly deactivating a charge switching component (34) without biasing the digital processing unit (21).

40. Electric tool set according claim 28 or any of claims 29-39, since it is dependent upon claim 28 , characterized in that the module for controlling and/or managing the battery comprises a discharge stopping redundant circuit (38') capable of ordering the interruption of the discharging if the measuring analog electronic unit (33) detects a discharging current equal to or greater than a maximum value allowed for the battery (5), by directly deactivating the discharge switching component (32) without biasing the digital processing unit (21).

41. Electric tool set according to any of claims 1-40, characterized in that the third charger sub-unit (4) adapted to recharging the lithium-ion or lithium polymer battery (5) generates a voltage with a precision approximating 0.5% and a controlled current, which are obtained by means of a special circuit for regulating voltage and current.

42. Electric tool set according to any of claims 1-41, characterized in that each functional sub-unit (2, 3, and 4) is mounted in a specific protective and/or gripping casing.